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Northwest Fisheries
Science Center

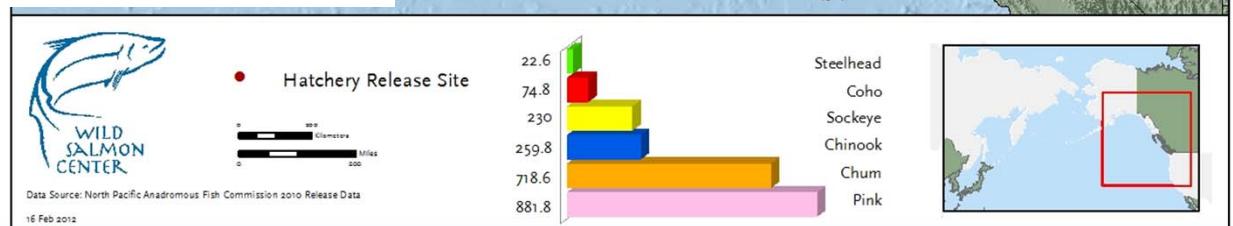
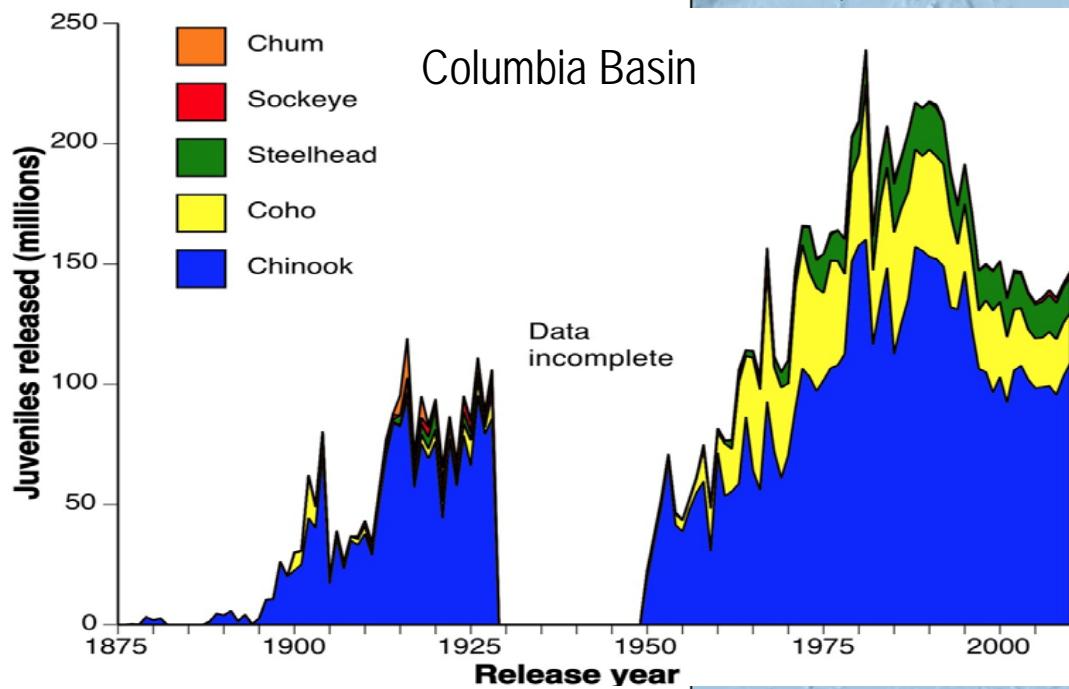
Environmental and
Fisheries Sciences

8.0 Overview of Hatchery Science

Barry Berejikian

5 May 2015

North America Hatchery Releases (in Millions)



Source ISAB



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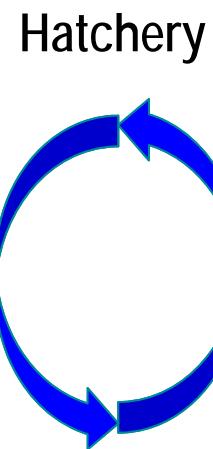
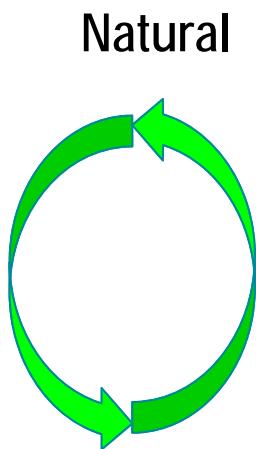
Broodstock management

Segregated:

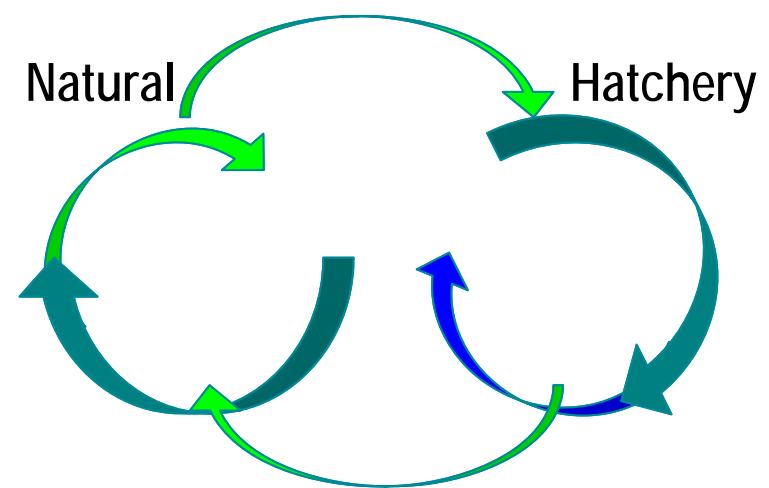
- hatchery-origin broodstock
- limited gene flow
- centralized hatchery
- harvest only

Integrated:

- natural-origin broodstock
- Intentional, regulated gene flow
- localized broodstocks
- harvest + conservation



Ideally 2 genetically separate populations



Gene flow between hatchery and wild environments



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Effects of hatcheries on Viable Salmonid Population Parameters

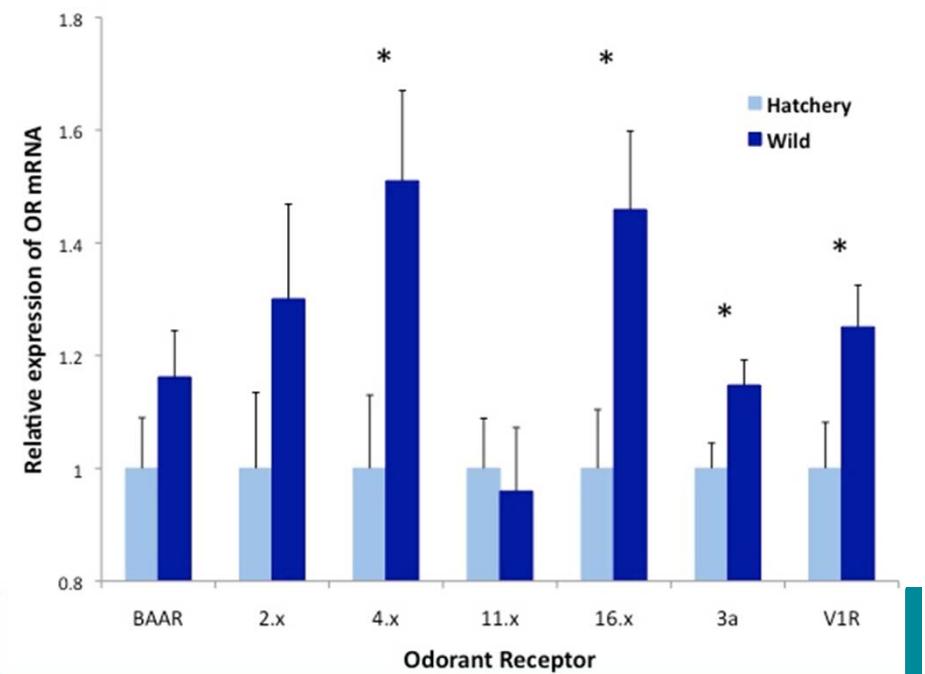
- Relative fitness of hatchery and natural-origin fish (8.1, 8.2)
- Supplementation effectiveness (8.2)
- Hatchery rearing environment effects on phenotypic traits:
 - Improve survival
 - Reduce negative ecological interactions
 - Domestication selection
 - Epigenetic mechanisms (9.1)
- Direct assessment of hatchery effects on VSP parameters



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Hatchery environment effects: improve imprinting and reduce straying

- Reduce interbreeding of wild and non-local hatchery stocks
- Maximize returns from supplementation or conservation hatchery programs.
- Two approaches
 - Evaluate pre-release acclimation during the parr-smolt transformation (via meta-analysis; Dittman et al in prep)
 - Embryonic imprinting (Dittman et al. 2015, *Fisheries*)



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Hatcheries can significantly reduce age-at-maturity in Chinook salmon

Factors Affecting Age of Maturation:

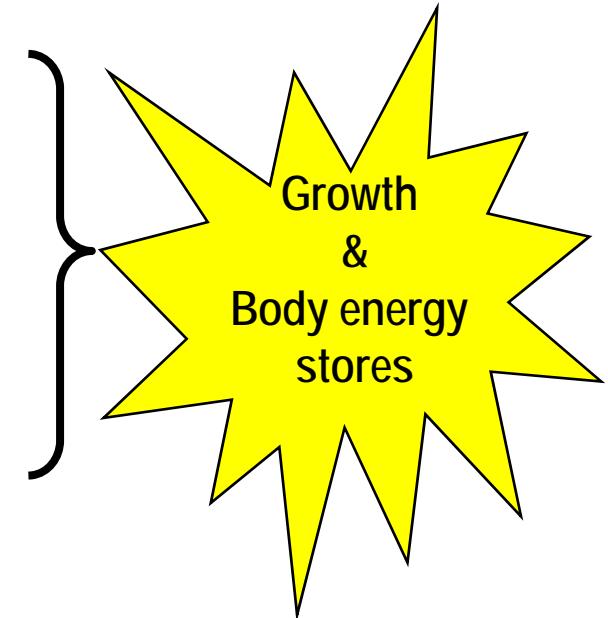


Mature male salmon

Ultimate causes

- ✓ Genetics
- ✓ Environment
 - temperature
 - food availability
 - food composition
 - emergence time

Proximate causes

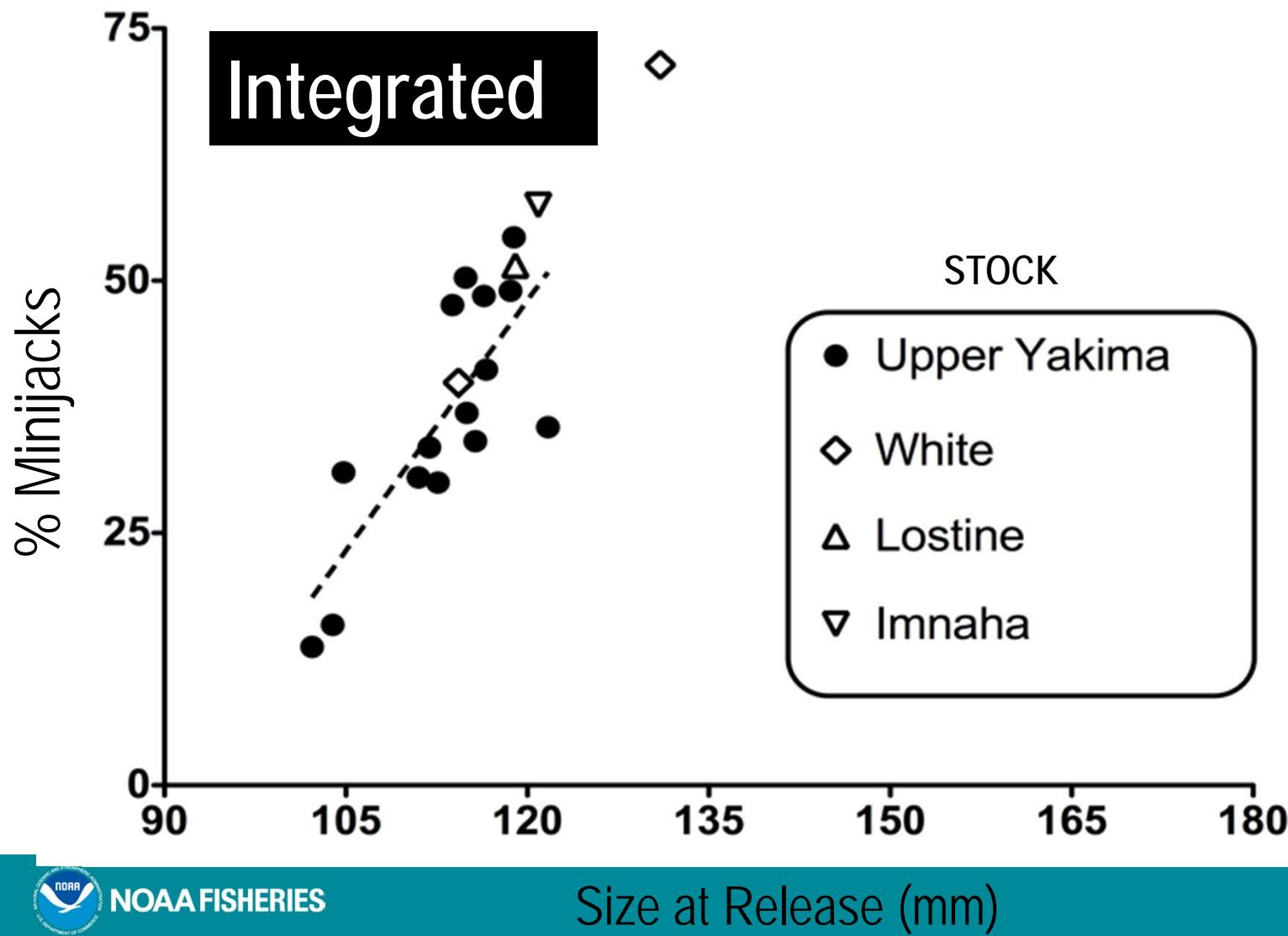


NWFSC: Larsen, Harstad, Beckman, Swanson et al.



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Minijack rate is strongly correlated with size at release

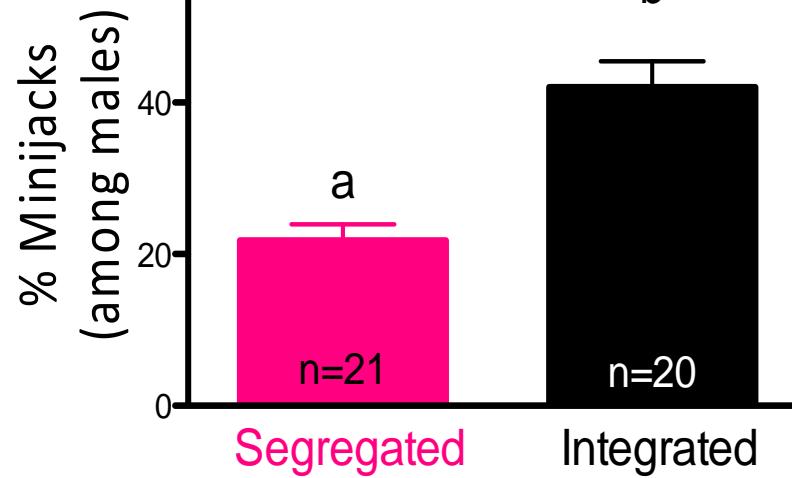
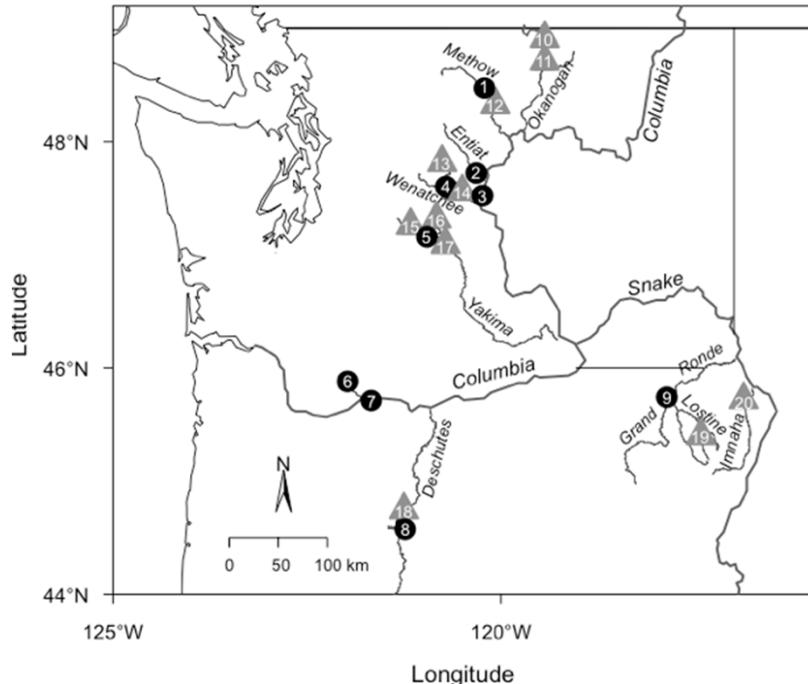
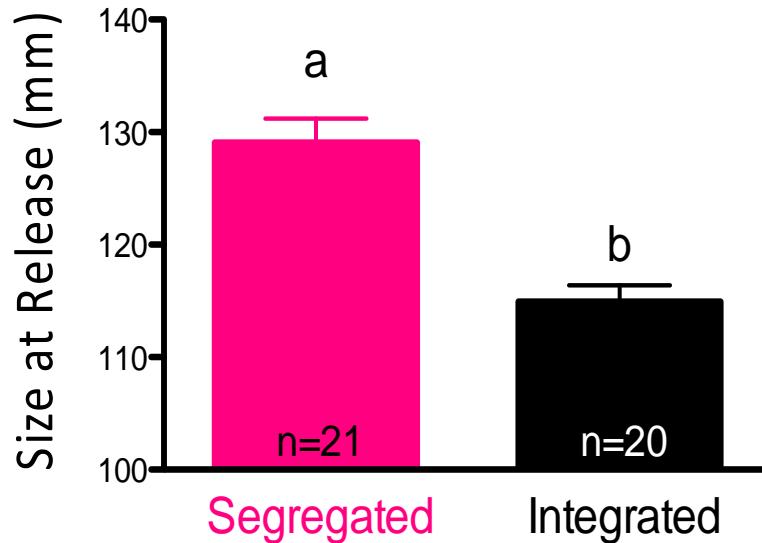


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Size at Release (mm)

Segregated vs Integrated broodstocks

Harstad et al. 2014

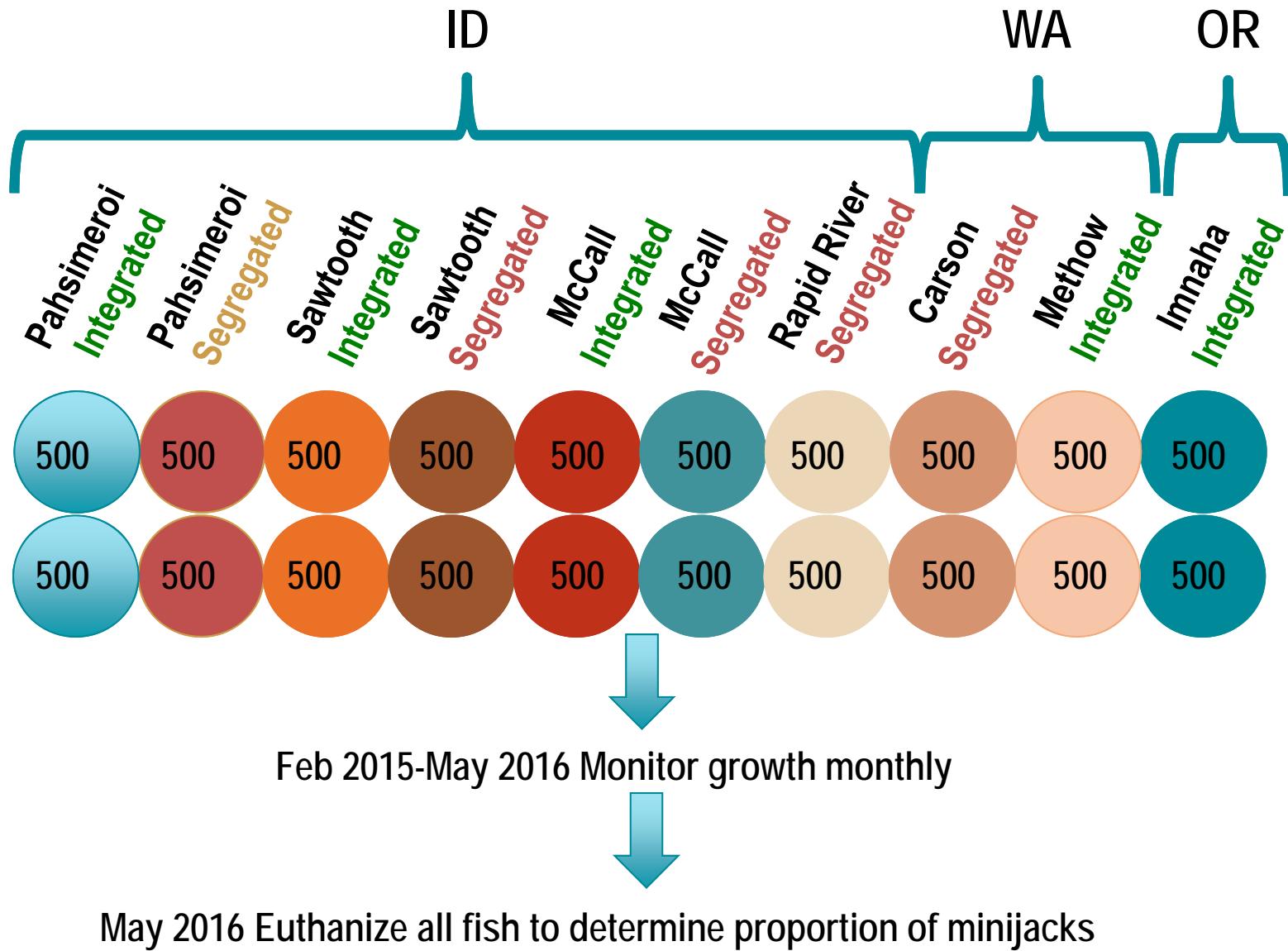


- Is this a result of domestication selection?



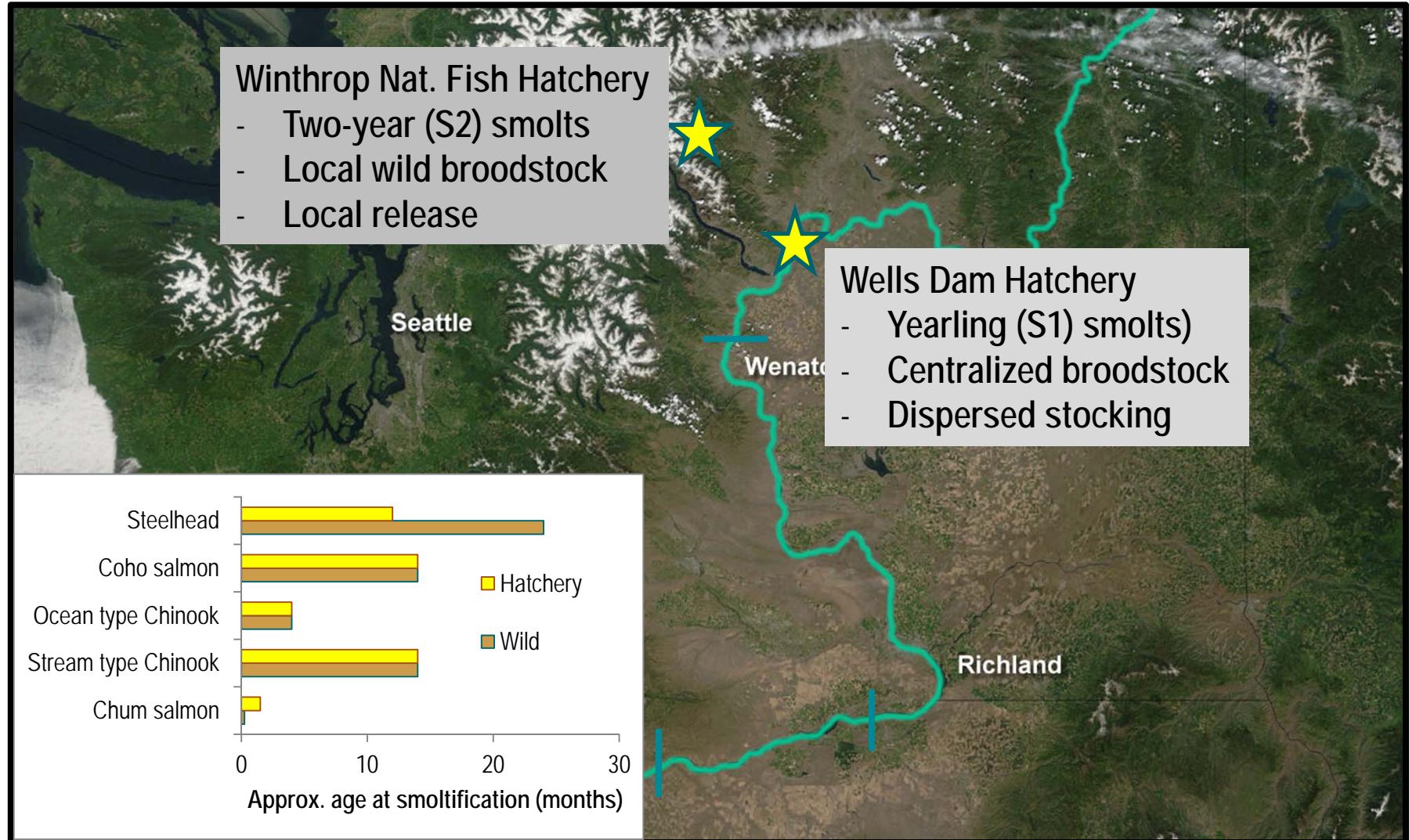
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Common garden experiment



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Modified steelhead rearing practices to meet emerging challenges



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Comparisons of S1 and S2 rearing strategies

Response Variables:

Downstream migration

Residualism

Smolt-to-adult survival

Male maturation

Smolt physiology

Reproductive success

Epigenetics

Heritability of growth rate/survival

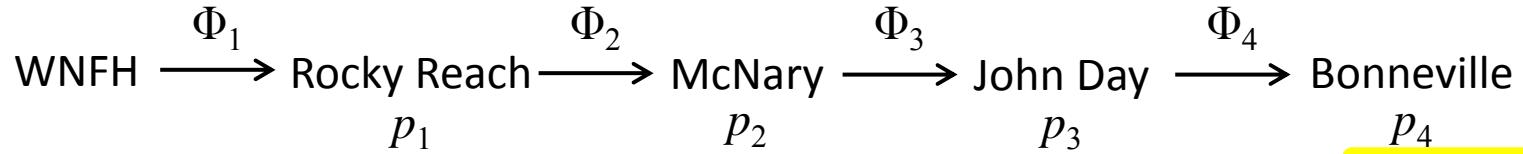
	Scale / Location	
	<u>Hatchery</u>	<u>Laboratory</u>
Downstream migration	X	
Residualism	X	
Smolt-to-adult survival	X	
Male maturation	X	X
Smolt physiology	X	X
Reproductive success	X	
Epigenetics	X	X
Heritability of growth rate/survival		X

NWFSC: Tatara, Swanson, Larsen, Berejikian et al.



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Downstream migration

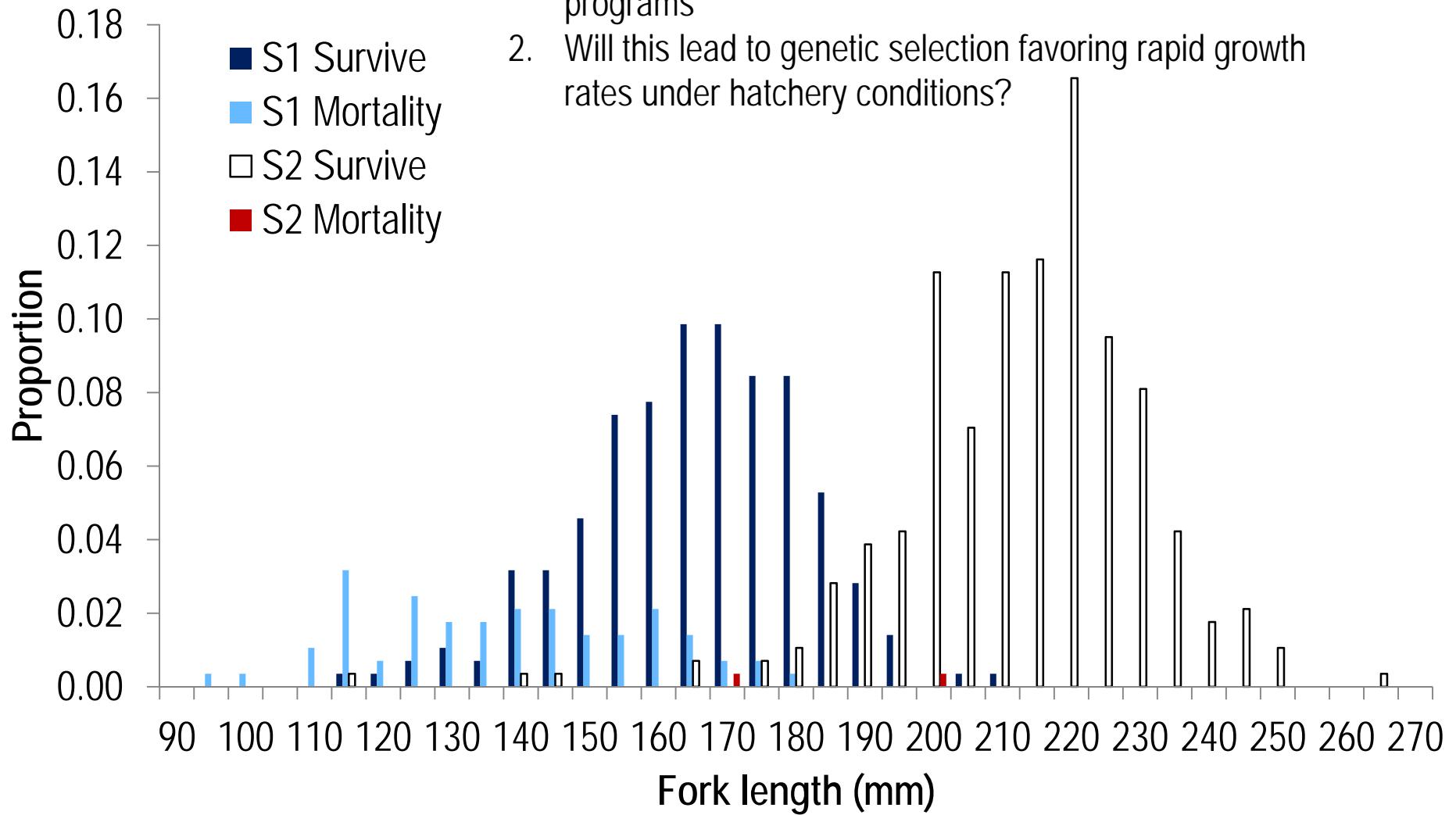


RELEASE YEAR	GROUP	# PIT TAGS RELEASED	SURVIVAL RELEASE-RR	SURVIVAL RR-MCN	OVERALL (JOHN DAY)
2010	S1	14,841	73.7 (2.4)	55.4 (10.1)	40.8 (7.3)
	S2	14,756	81.5 (3.0)	64.9 (12.7)	52.9 (10.2)
2011	S1	14,907	45.8 (1.8)	55.9 (5.3)	25.6 (2.2)
	S2	14,945	69.5 (2.1)	57.4 (4.3)	39.9 (2.7)
2012	S1	14,917	64.5 (2.1)	55.5 (4.3)	28.5 (2.2)
	S2	14,892	62.2 (2.3)	56.8 (4.8)	28.0 (2.4)
2013	S1	14,543	69.3 (2.2)	67.5 (10.1)	42.3 (5.9)
	S2	14,477	58.9 (1.7)	61.8 (6.9)	45.3 (5.6)



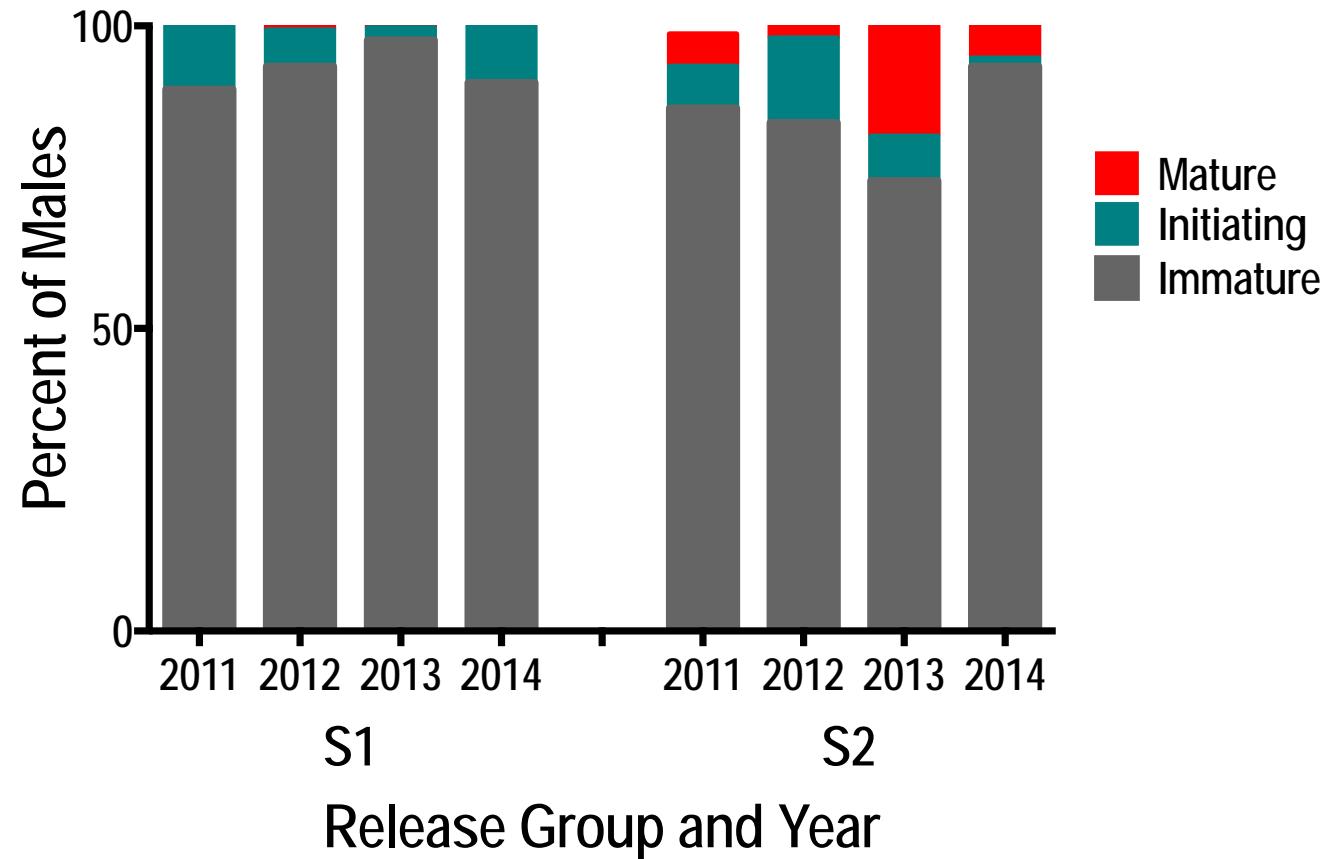
Body size and seawater survival

1. Selection for rapid growth rates in S1 but not S2 programs
2. Will this lead to genetic selection favoring rapid growth rates under hatchery conditions?



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Precocious male maturation



P. Swanson et al. (in prep)

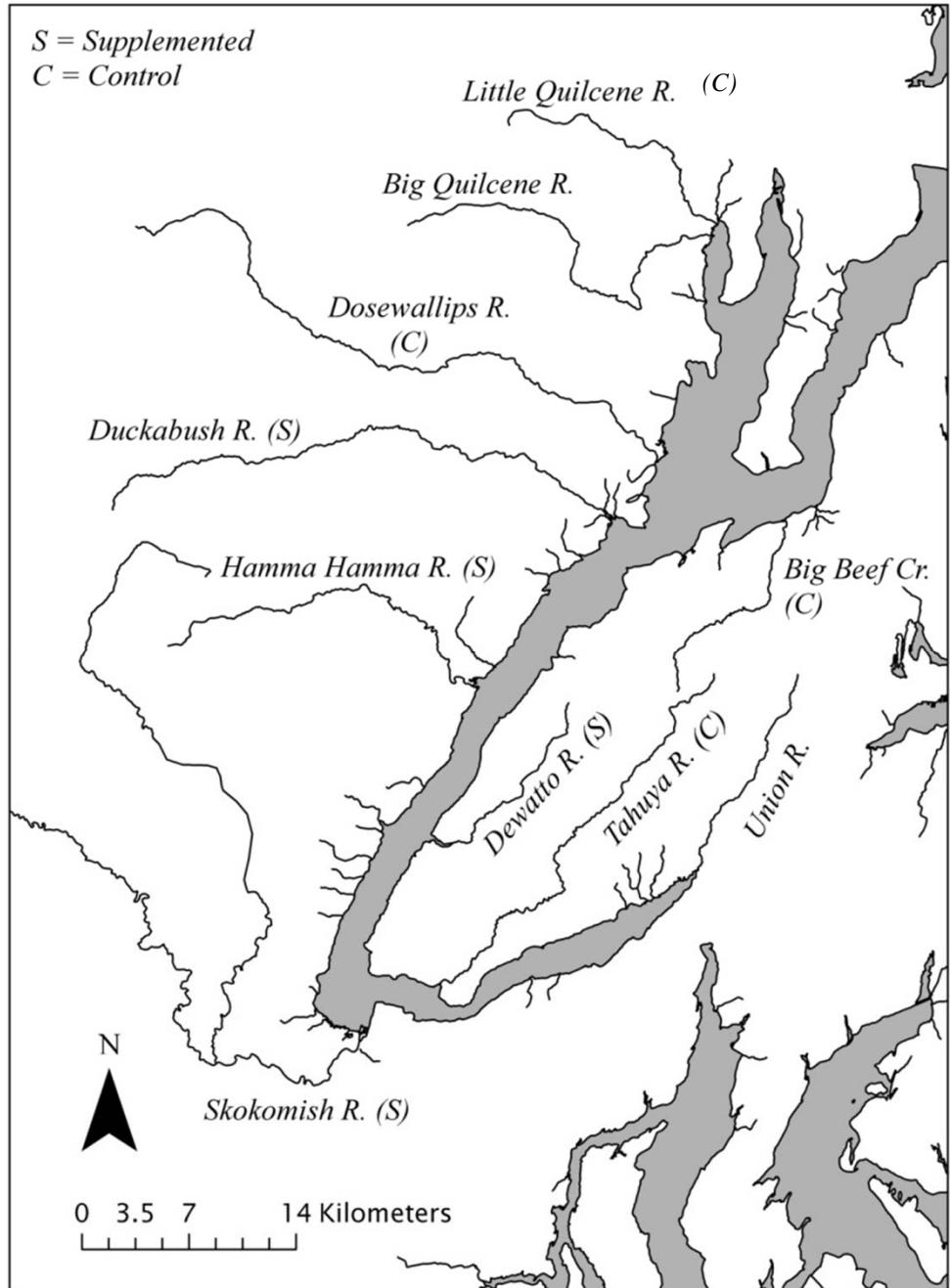


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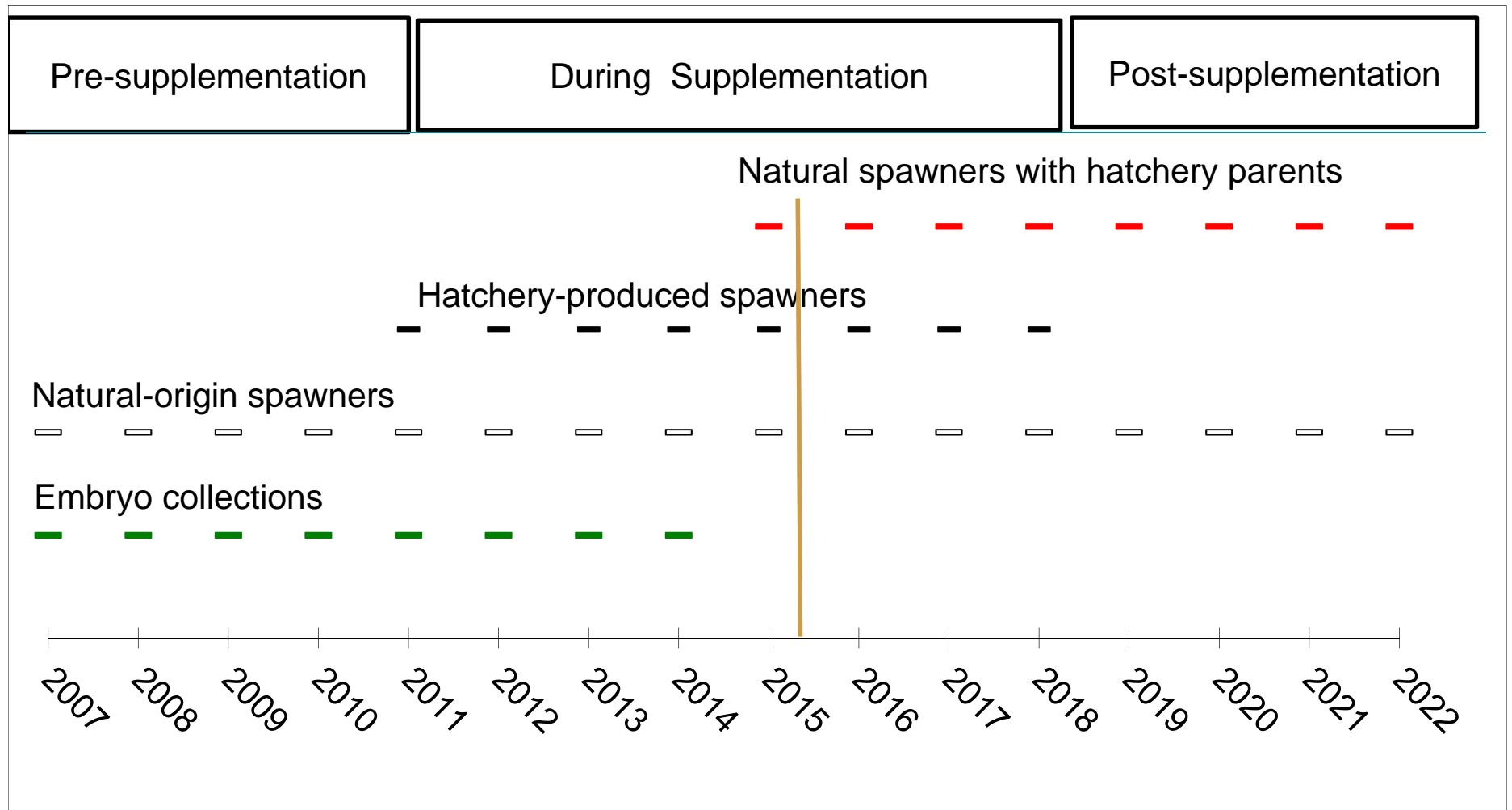
Effects of hatchery programs on VSP parameters

- Replicated, before-during-after-control-impact experiment (RBACI)
- Response variables =
 - spawner abundance and spawn timing
 - freshwater productivity (smolts/redd)
 - life history diversity (incl. anadromy)
 - genetic variation
 - Limiting factors (incl., early marine survival)



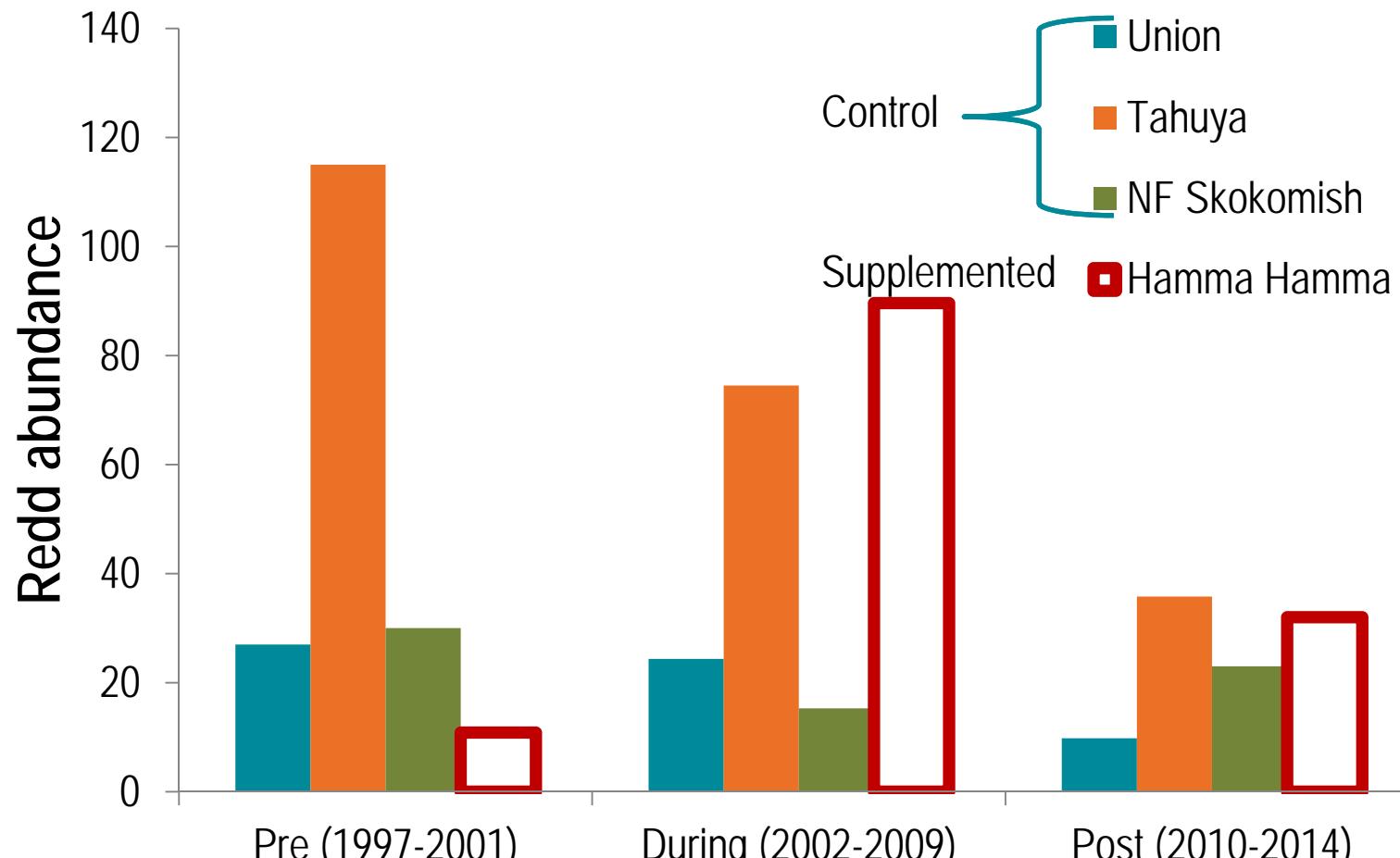
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Hatchery Experiment Timeline



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Redd abundance Hamma Hamma vs Control populations (1997-2014)



Berejikian et al. 2008. CJFAS & Berejikian et al. (in prep)



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Genetic Diversity

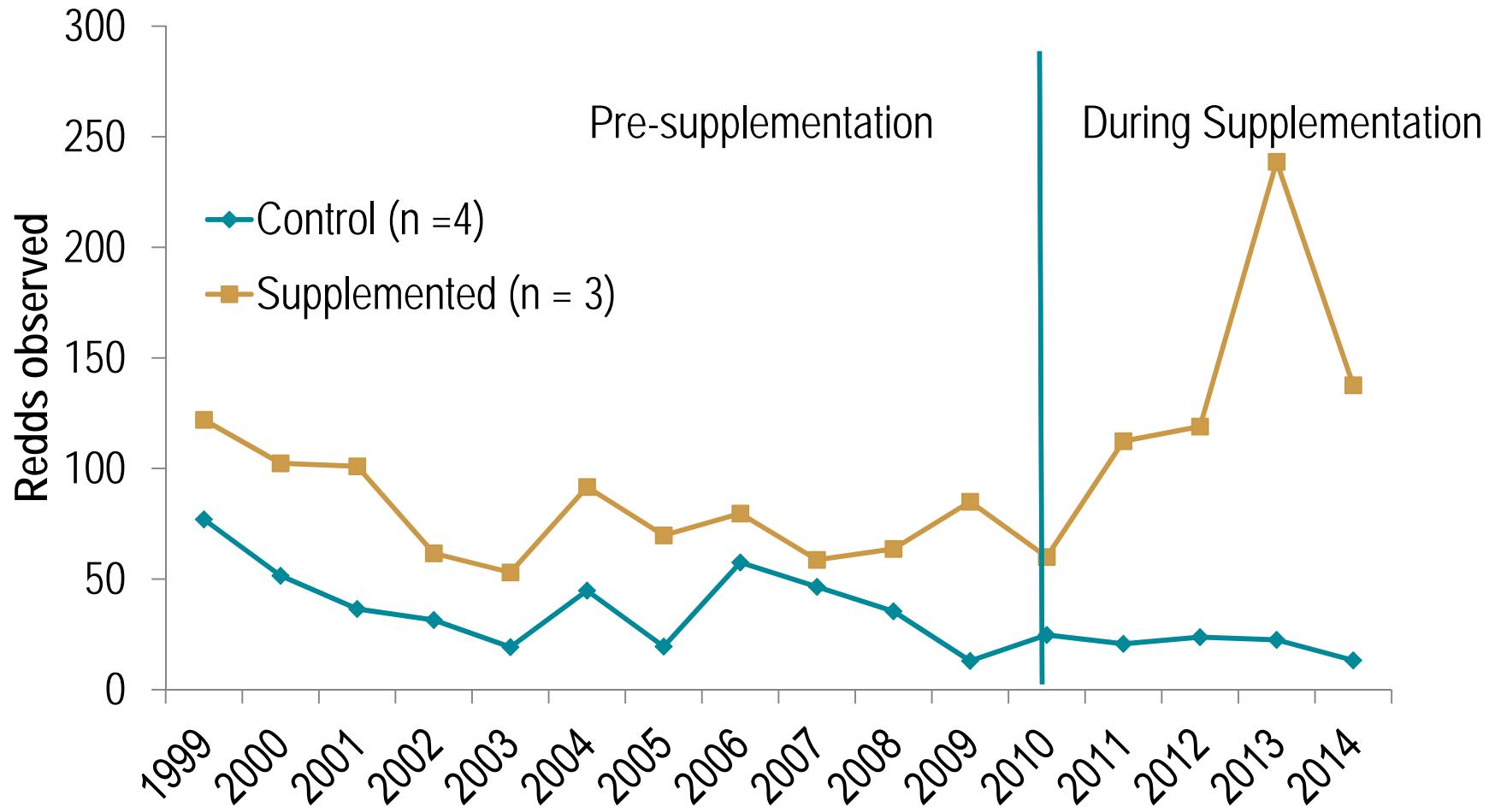
Summer parr	N	H _o	Alleles	Rare alleles	Unique alleles	A _r	Mean Nb
Before supplementation (1998-2001)	224	0.760	177	61	15	17.5	33
During Supplementation (2002-2004)	241	0.763	176	54	16	17.4	42

Van Doornik et al. 2010. Trans. Am Fish. Soc



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Redd abundance



Summary

- Methods to improve smolt quality continuing
- New hatchery strategies will require new and innovative techniques
- Emerging opportunities
 - How might changes in hatchery rearing environments reduce domestication selection?
 - How to quantify ecological interactions?
 - How quickly do hatchery influenced populations regain fitness?



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